THE METEOROLOGICAL CONDITIONS IN THE FREE AIR DURING TWO EXTREME WEATHER TYPES

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The author gives the results of his study of the vertical distribution of temperature, relative humidity, and wind direction over the Lake Constance region as regards its bearing on the weather of southwestern Germany, particularly the Alpine forelands. The data used comprised the kite records obtained at the aerological stations near Lake Constance during the years 1909–1915, these being grouped under two distinct types of weather, viz, with cloudless sky and during the occurrence of precipitation.

A. WITH CLOUDLESS SKY

There were 71 flights available under the first condition, distributed as follows: Summer, 39; spring, 19; autumn, 8; and winter, 5. The mean values found are given in Table 1.

TABLE 1

Altitude (m.)	395 (Surface)	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000
Δt/100 m.	0.03	–0.26	0.50	0.54	0.56	0.56	0.56	0.58	
Δt/100 m. (omitting inversions)	0.51	0.53	0.60	0.62	0.62	0.63	0.61	0.61	
Relative humidity	78	77	54	49	44	40	39	37	35

The author discusses his reasons for expecting a relatively steep average temperature lapse rate under these conditions and follows with explanation for the smaller values actually found.

Table 2 gives the percentage frequency of temperature inversions and isothermal layers which are most regularly present notwithstanding the absence of clouds.

TABLE 2

Altitude (m.)	395–800	810–1,200	1,210–1,600	1,610–2,000	2,010–2,400	2,410–2,800	2,810–3,200	3,210–3,600	3,610–4,000	4,010–4,400
Per cent	98	16	20	10	19	16	5	12	6	3

The comparatively high frequencies found between 2,000 m.–2,800 m. and at the 3,200 m. level are discussed and special emphasis placed on the fact that since these stratifications are frequently present even in cloudless weather it is therefore proved that they are not the result of cloud formation. Difficulties seem to arise, however, in accepting the hypothesis that descending air currents extend uniformly over great areas in the inner regions of anticyclones, as is generally supposed, since out of 67 ascents only 5 had no inversions, 19 had 1, 35 had 2, and 8 had 3 inversions.

The decrease of relative humidity up to over 4,000 m. would seem opposed to the supposition that the descent of air from higher altitudes is the cause of its dryness, since if this were true the humidity would necessarily increase with elevation. This latter condition, while found occasionally in individual cases, is not the rule. The fact that on cloudless days the humidity up to great heights amounts to 40–50 per cent is probably of significance in solar radiation measurements which are made in most cases under such weather conditions. The latter are thus related to an atmosphere which has a vapor content well below the mean up to the middle (at least) of the troposphere.

On account of the frequent presence of a transition layer with a calm between 500 m. and 1,000 m. over Lake Constance the usual method of representing the wind shift with height can not be used and the percentage frequency of the cardinal directions is therefore given in tabular form.

The south quadrant of an anticyclone is found to be the most frequent pressure distribution for cloudless weather in this region, since then the winds are opposite to the (Südföhn) foehn, which latter wind is usually accompanied by more or less cloudiness. An interesting relationship was found to exist between cloudless weather and the pressure change during the following 24 hours. In 70 per cent of the cases a fall in pressure occurred and this relation suggests a connection between cloudless weather and the moving anticyclone (cold wave) in which there frequently occurs a complete clearing of the sky.

B. DURING THE OCCURRENCE OF PRECIPITATION

There were 129 flights obtained during the occurrence of precipitation. The mean values found are given in Table 3.

TABLE 3

Altitude (m.)	Surface, 395	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000
Δt/100 m.	0.70	0.62	0.58	0.56	0.56	0.54	0.53	0.51	
Relative humidity	90	90	91	92	92	92	91	87	80

The strikingly different values found for the average temperature lapse rates as compared with those in cloudless weather are ascribed to several causes. In rainy weather the temperature changes below the rain cloud, whose lower limits lie on an average at about 1,500 m., follow the adiabatic rate for dry air while within the cloud the temperature changes according to the adiabatic rate for moist air. At greater heights, above 3,000 m., frequent inversions at the upper limit of the cloud diminish the mean vertical gradients.

The percentage frequency of temperature inversions are given in

TABLE 4

Altitude (m.)	395–800	810–1,200	1,210–1,600	1,610–2,000	2,010–2,400	2,410–2,800	2,810–3,200	3,210–3,600	3,610–4,000	4,010–4,400
Per cent	14	4	5	2	5	1	3	12	4	13

From this it is evident that outside of the surface layer inversions are rare below 3,000 m., while above this height they become more frequent, since the upper limit of the less dense rain clouds rarely exceeds this height.

The mean relative humidity values are found to be about 90 per cent from the surface to 3,000 m., above which they show a gradual decrease. The base of the Nb. clouds was found to lie below 1,000 m. in 33 cases, between 1,000 m. and 2,000 m. in 76 cases and above 2,000 m. in 17 cases. The average height of their upper limit was found to be 2,730 m. and their average thickness somewhat more than 1,200 m. In some of the individual cases, however, the upper limit of the cloud was not reached at 4,000 m. By far the most frequent cloud type found showed a gradual decrease in relative humidity without an inversion, i. e., a gradual dissipation of the cloud particles with no well defined boundary.

Only in rare cases was it possible to analyze the temperature distribution as regards the type of precipitation with a view to determining whether the latter was associated with the warm-front, cold-front or an occluded

Low. In relation to these types the following typical surfaces of discontinuity were distinguishable: 1. *Near the surface.*—These appear frequently on the front side of secondary depressions and are related to the shallow cold strata which are separated from the upper warmer current by an abrupt change in temperature. 2. *Inversions with Fr. Nb.*—The mean altitude of these clouds is about 600 m. below the main cloud mass and they are often accompanied by small inversions. With more observational data it would be interesting to investigate the relationship which this condition bears to the Bjerkness theory of surface discontinuities. An inversion was found directly below the main Nb. layer in only 2 cases. 3. *Inversions in the main Nb. layer.*—Slight irregularities are frequent here especially at the beginning and ending of precipitation. 4. *Inversions at the upper limit of the clouds.*—These occur only with relatively thin Nb. from which there is only moderate precipitation, most frequently above 3,000 m. in the A. Cu. level. An adequate explanation of any of the above general classes is hardly possible from the records of only one aerological station.

The author gives in tabular form the percentage frequency of wind direction up to 4,000 m. during the occurrence of precipitation. The predominating direction is west for all heights. The striking characteristic is shown that especially in southern Germany winds with a N-component greatly predominate over winds with a S-component during the occurrence of precipitation. In the Alpine forelands all winds from SE–W have more or less of the foehn character, while those blowing toward the mountains necessarily produce phenomena associated with the forced ascent of air currents. It was found impossible to classify these records according to definite pressure types since in 80 per cent of the cases there was found to be an irregular pressure distribution in which secondary depressions played an important rôle. This latter fact reveals the difficulties in the prediction of precipitation for this region.

Discussion.—The reference by the author to the decrease in the mean relative humidity up to over 4,000 m. and his inference therefrom relative to the supposition that the descent of air from higher altitudes is the cause of its dryness, etc., might lead the reader to suspect some undue influence of local character, since these observations were made near a lake. It therefore would seem of interest here to show the results found for the southeast quadrant of anticyclones in this country as determined from kite observations made at the Drexel Aerological Station near Omaha, Nebr., from 1915 to 1924. These are given in the following table and are based on 50 and 61 flights made during the summer and winter seasons, respectively:

Altitude (m.)		Surface 395	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000
Relative humidity.	Summer	78	72	62	57	50	45	45	43	39	40	44
	Winter	89	89	82	67	59	57	56	54	52	51	50

These data represent the ascent only, the average time of which occurred about 7 a. m. and 8 a. m. for summer and winter, respectively. This fact, of course, explains the rapid decrease in the lower levels from the relatively high values found at the surface. It is probable that the same method was used for the European data since this rapid decrease is even more pronounced than for Drexel. This latter fact, however, may be due in part at least to the proximity of the lake. While it is true the European observations were not made under the same conditions so far as the pressure distribution is concerned, yet the American observations were made during conditions favorable for cloudless weather and the downward movement of air. It is evident from this table that under similar circumstances in this country the same condition prevails, viz, a gradual decrease in the mean relative humidity with increase in elevation.—*L. T. S.*

SUNSPOTS AND THE WEATHER AT GALVESTON, TEX.[1]

By I. R. TANNEHILL

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The chief difficulty in coordinating solar and terrestrial conditions lies in the absence of complete series of observations on solar activity. Present observations of that nature cover too short a period to yield permanent results.

The variation in the number of sun spots as related to the weather on the earth has been the subject of numerous studies most of which probably are familiar to the reader. In some of these investigations it is assumed that the effect of changes in solar radiation will be felt throughout the atmosphere, as a general rise or fall in the temperature of the atmosphere as a whole, the effect being greatest in the Tropics. Others have assumed that the changes in the earth's atmosphere will be felt chiefly in the higher levels of the troposphere, that these changes will entail other changes in the surface pressure of the earth, etc. Still others claim, and with reason, that the correlation coefficients will be negative in one region and positive in another.

The writer presents in outline the results of studies of the records of a single station in an effort to associate changes in the spottedness of the sun with terrestrial weather changes.

The wind.—Data of frequency of south and southwest winds in summer months, 1871–1924, smoothed by taking the mean of three consecutive values allocated to the middle year were compiled and plotted in a curve. A curve was also prepared showing the changes from year to year in the frequency of southeast winds for the month of July. This curve is practically the inverse of the curve for south and southwest winds.

There is a rough parallelism between the frequency of south and southwest winds and the curve of sun spots, although the curves for the two elements are at times lacking in synchronism.

Wind velocity data for April and May, the two months best suited to the purpose of the investigation, were prepared and studied. No correction was attempted for the results of a change in the anemometer exposure made in 1901.

An increase in wind velocity with increase in sun spots is noted in four periods between 1880 and 1920, although here again the two curves are not closely congruent. The wind speed for July—a month in which accidental changes in wind speed are at a minimum, by reason of the small number of cyclones which approach within 500 miles of the station—is shown by two curves, the first representing the changes from year to year in the wind speed at the hour of least wind movement, near sunrise, and the second representing the changes for the hour of greatest wind speed, or the converse of the first.

[1] Author's abstract. Original text and illustrations are filed in Weather Bureau Library.